LAKE AND RAIL ELEVATOR
(International Milling Elevator)
(ConAgra Elevator)
120 Childs Street
Buffalo
Erie County
New York

HAER No. NY-251

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

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HISTORIC AMERICAN ENGINEERING RECORD

LAKE & RAIL ELEVATOR
(International Milling Elevator)
(ConAgra Elevator)
HAER No. NY-251

Location: 120 Childs St., Buffalo, Erie County, New York

Date: Mainhouse: building permit application February 24, 1927; approved March 2, 1927; completed August, 1927
North Annex: building permit application March, 1928; issued April 28, 1928
South & Southwest annexes: building permit issued April 10, 1929
Northwest Annex: building permit application January, 1930; issued March 10, 1930

Designer: Probably Jones Hettelsater Construction Co.

Builder: Jones Hettelsater Construction Co.

Status: Operational

Significance: The grain elevators of Buffalo comprise the most outstanding collection of extant grain elevators in the United States, and collectively represent the variety of construction materials, building forms, and technological innovations that revolutionized the handling of grain in this country.

Project Information: The documentation of Buffalo's grain elevators was prepared by the Historic American Engineering Record (HAER), National Park Service, in 1990 and 1991. The project was co-sponsored by the Industrial Heritage Committee, Inc., of Buffalo, Lorraine Pierro, President, with the cooperation of The Pillsbury Company, Mark Norton, Plant Manager, Walter Dutka, Senior Mechanical Engineer, and with the valuable assistance of Henry Baxter, Henry Wollenberg, and Jerry Malloy. The HAER documentation was prepared under the supervision of Robert Kapsch, Chief, HABS/HAER, and Eric DeLony, Chief and Principal Architect, HAER. The project was managed by Robbyn Jackson, Architect, HAER, and the team consisted of: Craig Strong, Supervising Architect; Todd Croteau, Christopher Payne, Patricia Reese, architects; Thomas Leary, Supervising Historian; John Healey, and Elizabeth Sholes, historians. Large-format photography was done by Jet Lowe, HAER photographer.

This is one in a series of HAER reports for the Buffalo Grain Elevator Project. HAER No. NY-239, "Buffalo Grain Elevators," contains an overview history of the elevators. The following elevators have separate reports:

NY-240 Great Northern Elevator
NY-241 Standard Elevator
NY-242 Wollenberg Grain & Seed Elevator
NY-243 Concrete-Central
NY-244 Washburn Crosby Elevator
NY-245 Connecting Terminal Elevator
NY-246 Spencer Kellogg Elevator
NY-247 Cooperative Grange League Federation
NY-248 Electric Elevator
NY-249 American Elevator
NY-250 Perot Elevator
NY-251 Lake & Rail Elevator
NY-252 Marine "A" Elevator
NY-253 Superior Elevator
NY-254 Saskatchewan Cooperative Elevator
NY-256 Urban Elevator
NY-257 H-O Oats Elevator
NY-258 Kreiner Malting Elevator
NY-259 Meyer Malting Elevator
NY-260 Eastern States Elevator

In addition, the Appendix of HAER No. NY-239 contains brief notations on the following elevators:

Buffalo Cereal Elevator
Cloverleaf Milling Co. Elevator
Dakota Elevator
Dellwood Elevator
Great Eastern Elevator
Iron Elevator
John Kam Malting Elevator
Monarch Elevator
Pratt Foods Elevator
Ralston Purina Elevator
Riverside Malting Elevator

The Lake & Rail complex was developed by International Milling Inc., which established a new milling operation in Buffalo in 1926-27. Within four years of the construction of the mill, a substantial elevating complex with an aggregate storage capacity of 4,400,000 bushels had been completed. The complex lies beside the Buffalo River between Perot Malting Company and Marine "A" Elevator. The site is characterized by an acute bend in the river where the elevator makes a 90° turn. The entire complex was the work of the Jones Hettelsater Company, which described itself as "engineers, designers and builders to the American milling industry." The company was based in Kansas City, Missouri, and its more usual field of operation was in the southwestern states. The complex is the only example of Hettelsater's work in Buffalo. The Northwest Annex is particularly unusual, featuring Buffalo's tallest (150') nest of grain bins. Although the main bins are cylindrical, they are enclosed within straight exterior walls that form intervening outerspaces.[1]

International Milling acquired the site for the complex in 1926. A substantial reinforced concrete mill was the first building erected on the site. A building permit for its construction was issued in 1926, and the structure was complete and ready to receive machinery by May of 1927. The mill was equipped and operational by August of that year.

The building is of concrete beam, pillar and slab construction with brick panel infill, 9 x 4 bays and a castellated parapet. Two rows of fourteen square bins are placed along the center line of the building for its entire length, where they occupy the area between the second and fifth floors. The bins are approximately 10' square and 35' deep. The southernmost transverse bay of the mill incorporates two rows of eight bins, 10' square and 70' deep, between the fourth and ninth floors. Prior to the construction of the Northwest Annex, the northern side of the mill lay close to the waterfront. However, the annex was over the original river line and the mill on an "inland" site in the bend between the Northwest Annex and the remainder of the elevator.

Plans for the Lake & Rail Elevator were first announced in August of 1926. The building permit for the mainhouse was approved in 1927. The elevator was built in conjunction with the mill and received its first shipment of grain in the second week of August 1927, one week before the mill was commissioned. The Jones Hettelsater Construction Company was awarded the contract for the construction of the elevator in February, 1927, while the design and construction of the marine towers was entrusted to the Monarch Engineering Company.

Although the designer of the complex is not known, the design is thought to have originated in the design department of the Hettelsater Company. The elevator is of conventional design and consists of slip-formed bins which rise from a full bin slab supported by basement pillars and beams. The unusual basement design features both a full bin slab and basement beams. The basement works were constructed using conventional fixed form techniques. Like other Buffalo elevators built in the 1920s, this elevator features a slip-formed concrete workhouse.

The concrete was mixed dry in a batch mixer, with water added to "make a quaky consistency, soft enough to flow but dense enough to permit no separation of the material." First-class well-seasoned Portland cement was used, and all shipments were accompanied by a complete laboratory report to ensure that material met the standards of the American Society for Testing Materials. Sand was well-graded from course (1-1/2") to fine (1/4") and sieve-tested to ensure it met specification. Where conventional form work was used, concrete was poured to the full depth of a member in one continuous operation. Eight hours elapsed between the pouring of columns and the placing of the structure above. The forms were not struck until the concrete was thoroughly set and could support the weight of the structure and live loads of construction. The basement columns did not bear any weight until five weeks after pouring.

For the slip-formed work, the concrete was placed in lifts of no more than 12" and the forms were moved so that "they drew easily, but slow enough to allow the concrete to harden sufficiently to bear its own weight and ensure that it did not fall out of the wall below the forms." All concrete was spaded and agitated in the forms, and the reinforcing bars were shaken to prevent the development of voids. It is unusual to find mechanical concrete consolidation techniques specified in slip-form work. More often, spading about the reinforcing was the only method of compaction permitted, as it was generally thought that mechanical methods would disturb the uncured and unsupported concrete below the forms. The estimated cost of construction was $300,000, providing storage at a cost of 18 cents per bushel.

The elevator's capacity of 1,600,000 bushels is stored in thirty main bins, one of which is vertically sub-divided, twenty interspace bins, nineteen outerspace bins and thirteen square and rectangular workhouse bins. The cylindrical bins are 23'-2" in inner diameter and rise to a height of 110' above the bin slab. They are arranged in three parallel non-interlocking rows of ten bins spread longitudinally on 28' centers and connected by 3'-6" long link walls. Transversely, the bins are in tangential contact, and the contact thickening extends for 4' either side of the center line. The arrangements at the southern end of the elevator are modified to provide for workhouse functions. The distance between the last two transverse bin rows increases to 11'-2". Within the enlarged space is a series of rectangular and square workhouse bins. Additionally, the central main bin adjacent to the northern side of the nest of non-cylindrical workhouse bins is vertically sub-divided. A part of the workhouse intended to house receiving and separating machinery was originally to be built over the bin, but this aspect of the plan was never completed.

There are two rows of eight interspace bins in the main block of storage north of the workhouse bins. These conventional bins occupy the interstices of the adjoining four main bins. Four truncated interspace bins in the area between the last two transverse bin rows occupy the space between two adjoining main bins and the straight transverse walls within the square and rectangular workhouse bins. These are similar in form and position to the nineteen outerspace bins, one of which is used to accommodate stairs and a personnel elevator.

The outerspaces are conventionally placed between exterior main bins and have the usual convex exterior walling built to the same radius as the main bins. The outerspaces of the elevator extend back to the link walls, while those of the end wall extend to the tangential thickening. They occupy all available positions on the elevation, but are only present on the northern end wall. The two outerspaces between the two easternmost transverse main bins have exterior walls that extend over a greater arc than the other outerspaces. Internally, however, these bins form part of the workhouse and are further sub-divided.

The arrangements below the workhouse are complex. The three elevating legs are on 15' centers across the width of the elevator. Between each elevating leg is a block of 2 x 2 bins measuring 5'-9" x 5'. A single bin measuring 3'-8" x 5'-2" is situated between the up and down legs of each elevator. The eastern outerspace is occupied by a rectangular 4'-6" x 10'-3" bin, together with an outerspace of more conventional form. The western outerspace contains a single 6'-3" x 4'-3" bin, but is principally used to accommodate stairs and a personnel elevator. The bin walls, the link walls and the minimum thickness of the tangential contact are 8". The proportions of concrete in the walls differ according to height. The first 20' of bin wall is constructed of concrete of a 1:1-1/2:3 mix designed to withstand 2,500 psi of compressive load. Above this point, the bins are of 1:2:4 concrete able to withstand 2,000 psi of compression.

The bin wall reinforcing is of deformed round rod. The vertical reinforcing within the internal wall is made up entirely of jacking rods--nine within the internal main bin walls and ten in the external bins. In the internal bins, the jacking rods are placed at the termination of the link walls, at the point of tangential contact and between these two locations to produce a spacing of 9'. In the outer bins, the external wall has two jacking rods on 7'-6" centers. A similar arrangement of jacking rods is employed in the outerspace external quarter walls. In the external walls, the jacking rods are supplemented by additional ordinary verticals. There are two verticals between the jacking rods and an additional one in the main bin wall close to the point of intersection of the quarter wall. These arrangements give 2'-6" spacing between the vertical elements of the reinforcing within the external walls. All verticals including jacking rods are of 1/2" round rod. The ordinary verticals are 13' long with successive lengths lapped and wired in the usual manner. The 3' jacking rods are connected by splicing sleeves. The verticals are 3" from the outer surface of the bin walls to give a minimum 2" concrete cover over the horizontal tank bands wired to the outside of the verticals.

The horizontal reinforcing consists of 153 tank bands of graduated rod and bar arranged at varying course intervals. The design of the horizontal reinforcing in the Lake & Rail complex is unique in Buffalo. Hettelsetter's design team favored tank bands of both rod and bar as a means of fine tuning the amount of tensile material at a given course interval. By virtue of its greater cross-sectional area, a bar of a given dimension contains more material than a similarly dimensioned rod. Like the contemporary Saskatchewan Elevator, the variation in coursing interval is slight, and the introduction of both round and square bar fine tuned the amount of tensile steel to predicted loads at particular bin heights. Such precise methods of matching tensile steel to bin stresses were much in vogue during the 1920s in Buffalo.

The first sixty-six bands to a height of 44'-6" above the bin slab are round rods arranged at 8" course intervals. The next fourteen bands to a height of 55' are of rod placed at a slightly increased course interval of 8-1/2". The next eighteen bands to a height of 69'-8" are in 9" courses. From 69'-6" to 86'-6" the tank bands are of 1/2" square bar. As the sectional area of the steel has been slightly reduced, the first sixteen square bands are at the reduced course interval of 8" to a height of 80'. For the next nine bands above this point to a height of 86'-6", the coursing interval of 9" is resumed. As the sectional area of metal is reduced, the coursing interval decreases. The first six 1/2" bands to a height of 90'-8" are placed at an 8" course interval. The next ten bands to a height of 98' are in 9" courses, and the top thirteen bands are at 12" course intervals. Each tank band consist of four 20'-7" long bars or rods, lapped in 36" lengths and wired together.

The quarter walls of the outerspace bins are uniformly reinforced with 153 courses of 1/2" round rod at coursing intervals corresponding to those of the main bins. A contact anchor of 1/2" round rod at the extremity of the tangentially thickened bin wall hooks over the bands of the adjoining bins. The link walls contain single link bars of 1/2" round rod that hook over the tank bands of adjoining bins at every course interval. The junction of the quarter wall and the main bin is filleted and contains a single contact anchor of 1/2" round rod. The anchors are placed on every course and are hooked over the horizontal bands.

The bins rise from a 12" thick bin slab reinforced by a regularly spaced grid of round rods on 12" centers. A hopper fill of slag concrete is placed upon the bin slab, which is surfaced with a mortar conical hopper slab. The slab is at a 45° angle and is arranged to discharge centrally through a steel draw-off spout placed within the bin slab. The main draw-off spouts have a maximum diameter of 9'-8". The interspace bins discharge asymmetrically via a slab mortar hopper that rests on slag concrete which slopes to a conical draw-off spout located towards the center line of the elevator. Outerspace hoppering is similar to that of the interspaces and discharges close to the link walls.

The bin slab is supported by six longitudinal rows of bracketed basement pillars that divide the basement into five aisles. The bin slab is elevated 10' above the foundation slab to provide a full height basement. The pillars are linked transversely by substantial basement beams, and longitudinal beams are placed below the end transverse rows of bins. The outer aisles are 12' wide, the inner aisles 7'-2" and the central aisles 7'-6". Although all pillars are 2'-2" in width, they decrease in dimension toward the center line of the elevator.

The basement beam is also 2'-2" but varies in depth across the width of the elevator, from 3'-6" deep above the outer aisles to 2'-6" deep over the inner aisles. There are four pillars and two basement beams below each main bin. The outer row of pillars is below the intersection of the main and outerspace quarter walls. Concrete panels between the exterior row of pillars form the exterior basement walling. As two-thirds of the basement lies below grade level, these walls are pierced by elongated top lights. The basement beams are reinforced with trussed round rods ranging in size from 1" to 1-1/2". The rods extend into and form an integral part of the bin slab reinforcing system. The beams over the outer aisles are reinforced by four 1-1/2" rods and thirteen 1-1/4" rods. The beams over the inner aisle are reinforced with eight 1" rods, while those above the central aisle contain only three 1" rods. The pillars are reinforced with verticals placed on 5" centers, 2" behind their faces, and bound by horizontal hoops on 12" centers.

The elevator is built on reinforced concrete cylindrical caissons 5' in diameter. These are located below every basement pillar and support an 8" thick floor slab reinforced by upper and lower systems of longitudinal rods on either side of every caisson. In the immediate area of each caisson, an additional set of non-continuous twin rods is placed in close proximity to the main grid.

The bins are covered by a monolithic reinforced concrete bin floor. This floor is protected by a single-story reinforced concrete gallery that extends three-quarters of the width and the full length of the structure. A slip-formed reinforced concrete workhouse is located above the bin floor at the southern end of the building. The 197' tall, 56' x 36' workhouse rises above the last transverse row of cylindrical bins and the non-cylindrical bins located between the last two transverse rows of cylindrical bins. The thirteen rectangular and square bins serve workhouse functions together with the four adjoining truncated interspace bins and one outerspace bin. The three stories above the bin floor include a distribution floor at 133', a scale floor at 154' and a head floor at 189'. Three concrete garner bins are positioned below the head floor. These 12' deep bins are 19'-6" square, and each has nine draw-off spouts between hopper beams that measure 4'-6" x 1'-2".

On its northern side, the structure incorporates two 15' x 13', 21" deep storage bins. These were probably intended to feed the cleaner house that was to extend northward from the existing workhouse at distribution floor level. The elevator is equipped with a four-track structural steel and corrugated iron railroad loading shed located below the workhouse. The elevator's two marine towers were built by Monarch Engineering to its standard design. They contain re-elevating machinery and therefore rise to a height of 160'.

In 1928, the North Annex was built by the Jones Hettelsater Construction Company to the basic design of the mainhouse. It was constructed at a cost of $100,000, providing storage at a cost of 15 cents per bushel. The elevator measures 111'-4" x 72' and contains 650,000 bushels of storage in twelve main bins, eight interspace bins and eight outerspace bins. The Annex is comprised of three parallel non-interlocking rows of four bins each. The bins are of the same dimension and geometry as those of the mainhouse. Two rows of three interspace bins are located between the main bins. Additionally, two interspace bins were created at the juncture of the annex and the mainhouse; however the volume of these bins is reduced by the presence of the former outerspace bins located in the end wall of the original elevator. Eight interspace bins of conventional form are situated in all available locations. The two bins located on the end wall are horizontally divided to create upper shipping bins.

The structural elements of the elevator resemble those of the mainhouse. However, for reasons that are unclear, the outer rows of main bins discharge slightly asymmetrically. The draw-off spouts are located toward the center line of the elevator. The quayside and marine tower tracks extend along the length of the new annex, enabling the marine towers to serve the annex directly.

Soon after the completion of the North Annex, a three-story mill warehouse and railroad loading shed was built between the mill and the annex. The warehouse is of concrete construction with brick panel infill. The South and Southwest annexes were built under a single contract in 1929. That contract was let to the Jones Hettelsater Construction Company in January 1929. The original plans dated March, 1928, show that the original intention was to build no more than the South Annex. Modified plans submitted in February, 1929, include the Southwest Annex.

The South Annex broadly follows the pattern established by the mainhouse and continued in the North Annex. The Southwest Annex has a distinctive appearance, being broadly triangular in plan with the western elevation featuring a sweeping concave bin line. This unusual shape was an attempt to maximize storage capacity within the available land area. The curvature of the western elevation follows the curving railroad tracks that lead to the railroad loading shed. The railroad loading shed located below the mainhouse workhouse would have required relocation had any other plan been adopted. The cost of both the South and Southwest annexes was estimated at $250,000, providing storage at a cost of 25 cents per bushel.

Although the South Annex measures 122'-2" x 72' and maintains the alignment established in the mainhouse, the southern end wall is built on a diagonal to provide maximum storage up to the property line. This alignment is maintained along the southern elevation of the Southwestern Annex. There are three rows of main bins--a riverside row of four bins 23'-2" in diameter, a central row of four bins 23'-2" in diameter with a fifth full cylindrical bin 14'-4" in diameter between the two southern most large bins, and an inland row of five bins 23'-2" in diameter. Transversely, all except the 14'-4" bin are in tangential contact. Within the block of 3 x 3 bins closest to the mainhouse, the bins are spread longitudinally on the 3'-6" long link walls common to the rest of the complex. However, these arrangements are modified toward the southern end of the structure to accommodate the maximum number of standardized bins within the property line.

The last two bins of the riverside bin row are in tangential contact, and the small cylindrical bin is in tangential contact with the adjoining standard bins. The last three bins of the inland bin row are spread on reduced centers. Six interspace bins of conventional form occupy the interstitial space between the mainhouse and the annex. There are also three interspaces arranged about the small cylindrical bin and one occupying the interstices between the last bin of the central row and the last two bins of the landward row. Three additional interspaces broadly correspond to those areas that would have accommodated outerspace bins had the Southwest Annex not been added to the scheme. Six outerspace bins of conventional form occupy all available locations with the exception of those between mainhouse and annex.

The arrangements in the Southwest Annex are more complex. Cylindrical bins of 23'-2", 20'-6", 18", 16'-6" and 15'-6" are employed in the structure. The various main bins forming the southern and northwestern elevations meet at a 23'-3" bin, and terminate at the southwest apex of the elevator in a bin 16'-6" in diameter. From the common 23'-3" bin to the intersection with the South Annex, the bins of the northwest elevation are 18', 16'-6", 16'-6", 15'-7", 23'-2" and 18' in diameter. Those of the south elevation are 16'-6", 18', 16'-6" and 18' in diameter. The area between these bin lines accommodates three additional full cylindrical bins--an 18' bin and a 16'-6" bin along the junction with the South Annex, and a single 20'-6" bin between these bins and the common 23'-2" bin mentioned above. The outerspaces between the bins of the northwestern and southern elevations are occupied by fifteen outerspace bins of varying capacities but featuring the usual convex outer walls. Eleven interspace bins of different complex geometries occupy the interstices between the main bins.

The reinforcing arrangements within the bins resemble those of the mainhouse irrespective of the diameter of the main bins. The basement arrangements in the South Annex are analogous to those of the mainhouse. The arrangements within the Southwestern Annex are more complicated but also feature basement pillars and beams. The bin floor of the South Annex is of monolithic reinforced concrete. Unlike the typical bin floor, it features a 7' wide and 3'-6" deep trough that accommodates the conveyors. The reason for this departure from normal practice is unclear. The bin floor is protected by a single-story gallery of reinforced concrete three- quarters of the width of the elevator.

The overall gallery in the Southwest Annex provides slightly less headroom. The end-wall is of book tiles. A marine tower track extends along the quayside beside the South Annex, and the towers discharge directly to the annex.

The Lake & Rail Northwest Annex was the final addition to storage capacity at the International Mills complex. The annex design represents the Jones Hettelsater Company's successful attempt to maximize storage capacity on a very limited site. The site measures 237' x 52', and provides storage for 1,500,000 bushels of storage. At 150', the elevator features the tallest nest of bins in Buffalo, although the freestanding bins of the Kellogg Loading Elevator exceed those at Lake & Rail by 10'. The arrangement of cylindrical main bins within straight exterior walls maximizes the volume of the outerspace bins lying between cylindrical bins of small radius. The Ralston Purina "A" Elevator and the Meyer Malt Elevator are the only other Buffalo elevators of similar design.

The elevator was built in 1930 by the Jones Hettelsater Construction Company and was probably a product of that company's design team. The estimated cost of construction was $220,000, providing storage at 19 cents per bushel of capacity. The grain was contained in forty-two main storage bins, twenty-six interspace bins and thirty outerspace bins. The bins extend to a height of 150' above the bin slab. The main bins are 15' in diameter and are arranged in three non-interlocking rows of fourteen. The bins are spread and connected by 1' longitudinal link walls and 2' long transverse link walls. One main bin is horizontally sub-divided to provide an upper shipping bin. There are two rows of thirteen interspace bins of conventional geometry, and thirty outerspace bins occupy all available space between the main bins. Twenty-nine of these bins are used for storage, while the outerspace between the North and Northwest annexes accommodates a personnel elevator. These bins are unusual in having straight exterior walls rather than "quarter" convex walls.

Although geometry provides more storage volume, it only appears to have been employed where relatively small main bin diameters limited potential outerspace volumes. The employment of straight exterior outerspace walls as a means of gaining additional outerspace bin volume was only practical for the short spans between narrow, closely spaced bins. A diameter of 19' appears to be the maximum bin size for this arrangement in Buffalo. Over such distances, the straight wall could be reinforced as if it were an arched quarter wall. Over greater distances, straight walls had to be reinforced as beams, requiring larger amounts of reinforcing to be placed in a more complex geometries.

There are eleven square and rectangular overhead bins between the elevator and the mill. Seven measure 10'-9" x 6', two are 12'-9" x 8', and the two remaining are 12'-9" x 8' and 8'-9" x 6'. The depth and function of these bins is not known. The main bin walls and exterior straight walls are 6" thick. The link walls are thickened to the dimensions of the basement pillars for the first 20" above the bin slab, where they become 1'-9" thick. The straight exterior bin walls do not enclose the cylindrical walls of the outer row of main bins. Rather, the outermost part of the cylinder is incorporated into the straight wall bridging the two adjacent cylinders. The plans show three transverse passageways immediately above the bin slab and below the second, fourth and eighth transverse rows of bins. These passages extend across the width of the structure but do not pierce the riverside outer wall. As the bins do not discharge into these passageways, their function is unclear.

The vertical reinforcing of both main cylindrical bins and the exterior straight wall consists of a combination of jacking rods and ordinary verticals. Eight jacking rods are placed equidistantly about the circumference of the main bins on 5'-9" centers. The jacking rods are supplemented by eight ordinary verticals. A single such vertical is placed between each jacking rod to give a combined spacing of 2'-7" for the verticals. The exterior wall verticals are on 2'-6" centers and are comprised of jacking rods placed centrally in the bridge wall. The outermost jacking rod of the outer cylindrical bins is placed in the part of the wall common to straight and cylindrical walls. Two ordinary verticals located between each of these jacking rods produces the required spacing. Jacking rods and ordinary verticals are of 1/2" round rod. The jacking rods are in 3' lengths with splice connections, and the ordinary verticals are 15' long and wired together.

The horizontal reinforcing consists of 209 tank bands of bar and rod at varying course intervals. The horizontal reinforcing exhibits the characteristic Hettelsater combination of round rod and square section bar designed to maintain a particular coursing interval or range of coursing intervals. The first 169 tank bands are of square bar on 8-1/2" course intervals to a height of 120'. Above this point, the reinforcing is of round bar. As the tensile stresses are reduced, less tensile material is required for a given course interval. Between 120' and 130', there are fifteen bands placed in 8" course intervals. The next thirteen bands are at a course interval of 9-1/2" to a height of 140', and the top eleven bands are at a 10" course interval. Each band is made up of three 18' long rods or bars lapped over a distance of 18" and wired together. The straight walls are reinforced by similarly dimensioned steel at the same course intervals as the main bins. The bins are capped by a 5" thick monolithic concrete bin floor.

The bins rise from a 15" thick bin slab supported by a network of basement pillars. Basement beams are not employed in this part of the Lake & Rail complex. This arrangement provides a full basement with 10'-3" headroom. Hoppering is provided by conical mortar hoppers resting on slag concrete fill placed upon the bin slab. The outer row of main bins discharges centrally. The inner row discharges asymmetrically, spouting close to the side of the bin wall closest to the riverside bin row. The central bins discharge to the conveyor below the riverside bin row, and this arrangement ensures that a viable spouting angle is maintained from the central bin row. All bins discharge through conical steel draw-off spouts set within and extending below the bin slab.

The bin slab is supported directly by seven rows of non-bracketed pillars that divide the basement into six longitudinal aisles. The 10'-3" high pillars are situated below every link wall connection. Those beneath the transverse link walls measure 4'-6" x 2'-9", while those below the tangential link walls are 3'-7" x 3'. In an arrangement unique in Buffalo elevator design, the pillars extend beyond the bin slab to a height of 20', providing a massive link wall between the lower parts of adjoining bins. The reinforcing of the columns and bin slab is not known. The columns are designed to carry a load of 1,442,000 pounds.

The elevator is built on reinforced concrete sub-piers of 4'-6" diameter that extend to bedrock. They are placed below every basement pillar and support a 12" thick reinforced concrete floor slab. The bin floor is covered by a single-story 10'-6" tall concrete gallery to three-quarters of its width. The annex contains no independent elevating machinery to transfer grain from basement to bin floor level conveyors. However, the height difference between the Northwest Annex and the North Annex requires that grain be elevated between the bin floors of the main complex and the Northwest Annex. This elevating equipment is housed in the small steel and corrugated iron workhouse above the North Annex and abutting the end wall of the Northwest Annex.

With the completion of the Northwest Annex, development at the site was virtually complete. Soon after the completion of the North Annex, a fixed-steel marine tower was installed beside it, and in 1933 a steel drier and workhouse were erected. In 1960 a grain car dumper was installed in a 84' x 30' steel shed to the south of the Southwest Annex.

BUSINESS HISTORY

The Lake & Rail Warehouse and Elevator was built in 1926-1927 as part of what was then the second largest flour milling company in the world, International Milling Company. The company had modest origins in Faribault, Minnesota, where founder Francis A. Bean established a mill that went bankrupt in 1891. The next company began a year later in a rented mill at New Prague, a town thirty-five miles southwest of Minneapolis. New Prague Flouring Mill Company expanded capacity in 1896 before acquiring mills in Blue Earth and Wells. In 1904 Bean added mills in Davenport, Iowa, and Moose Jaw and Calgary, Alberta. By 1900 the bankruptcy debts from Bean's first venture were all retired despite the fact that he was no longer legally obligated to pay them. Bean retired from active control in 1910, and his son, Francis, Jr. (Frank Bean) assumed control. Frank changed the company name to International Milling to reflect the Canadian holdings, and built the small but lucrative firm into a large enterprise which, by 1980, was the 45th largest food producer in the United States.[2]

Although the company moved its headquarters to Minneapolis in 1923, it incorporated in Delaware as International Milling Company, which assumed control over the entire business. By the later 1920s, International Milling had expanded operations to other Canadian elevators and mills, especially in Saskatchewan, and had also begun plans to build a new facility in Buffalo.[3]

In November, 1926, the Lake & Rail Warehouse & Elevator Corporation was founded in Buffalo with three New York City incorporators. Less than a month later, the new board of directors, including Frances Bean, Jr., consented to a mortgage of $2 million. The trustee for the debt was Manufacturers & Traders of Buffalo, but interest was payable in gold through the Canadian Bank of Commerce.

At that same meeting in December, 1926, Lake & Rail voted to lease its new elevator and mill to International Milling, owner of all the Lake & Rail Company stock. Such lease-back arrangements were generally established for cost-cutting and tax avoidance purposes and to minimize subsidiary autonomy. International Milling agreed to pay all costs, taxes, insurance, repairs, maintenance and cash rental "sufficient to pay all interest charges and sinking fund requirements" on the debt. In exchange, the parent company could deduct those costs completely from their income. According to Moody's <u>Industrials</u>, this was the only arrangement of its type in International Milling at the time.[4]

Lake & Rail had its first incarnation as Interstate Elevator Corporation based in New York City. It was under this name in 1925 that the company acquired the property upon which the elevator was to be built. The company issued a quit claim on the property along the dock line, ceding control to the City of Buffalo to enable channel dredging of that section of the Buffalo River. In exchange, Interstate obtained immunity from all charges or taxes resulting from the river improvement on the remaining property. Further, Interstate retained all riparian rights to the property along the river and on the "uplands" beyond. When the company later incorporated as Lake & Rail Warehouse & Elevator, these rights were retained.[5]

Construction of the elevator, the flour mill, grain storage, and warehouse proceeded from 1926 to 1930. International Milling established permits for the mill in December, 1926, and for phases of the elevator expansion in 1927, 1928, 1929 and 1930. The elevator sections included the 1926-1927 1.6-million-bushel facility to which was added a 650,000 bushel "B" tank annex in 1928,a 1 million section in 1929, and a 1,150,000 annex in 1930. The 5,000 cwt. flour mill was completed in May, 1927, and two marine legs were built onto the elevator in July of that year. At the completion of the basic work, the Buffalo plant became International Milling's single largest facility.[6]

The flour milled by International was marketed retail under the brand "Robin Hood", originally a Canadian flour trade name. The $3 million Buffalo plant went into production in August of 1927 with a 5,000-bushel-per-day capacity. International Milling also produced several merchant lines of grain products. During World War II, the company converted surplus wheat into alcohol grits used in making synthetic rubber. Simultaneously, it began to purchase other milling companies and build a new mill in Canada. Between the outbreak of the war and 1954, International acquired eleven plants and built the Humberstone Mill.[7] Frank Bean's son, Atherton, was an official with the wartime rationing authority, Office of Pricing Administration. He was in charge of establishing price ceilings on milled grain products, a program considered to be one of the best formulated of the era.

Direction of the company's growth was largely in the hands of Frank Bean and his brother Harvey, who served as vice president and president respectively. The other directors came from three principal areas--Minneapolis, Buffalo, and Toronto. The closely-held alliance, populated primarily by those employed within the company system, consolidated control and kept direction in company hands.[8] In September, 1937, the formal separation of Lake & Rail and International Milling ended with the dissolution of the Buffalo elevator subsidiary. Upon liquidation of the Western New York company, International Milling received all assets and property and assumed the $1.5 million mortgage that Lake & Rail had taken with Guaranty Trust Co. of New York, a J. P. Morgan bank. Now Lake & Rail Elevator was the only entity with that name, and the operating company ceased to exist.[9]

The Lake & Rail Elevator continued to serve the company well for several more decades. International Milling shipped a great variety of wheat to the elevator and mill. The different wheats gave the mill a large range of flour types to feed a dozen or more markets, including that established for the Robin Hood consumer brand. In 1963 International Milling ceased its formal incarnation as a Delaware corporation and relocated to New York State where, the company said, modern corporate laws outweighed Delaware's tax advantages. New York in particular provided protection from corporate "raiders" who, even at this early date, sought to absorb lucrative and stable companies such as International Milling. Effective September 1, 1963, a new company, IMCO Milling, was to be established with $25 million in capital stock. The corporation would be based in Buffalo, the Delaware firm assets would be merged into IMCO, and a second version of the earlier company would be created--International Milling, Inc.[10]

In the late 1960s and early 1970s the company once again changed its name and product focus. As International Multifood, the company developed new product lines and engaged in it own corporate acquisitions of companies strongly involved in prepared foods. International Multifoods pioneered the introduction of "Merlinex" a non-nutritive cellulose extender used as a substitute for natural ingredients and as an enlarger of other foodstuffs, such as long, one-pound loaves of bread. Basic grain trade and milling took a back seat to these expanding food processing operations.[11]

International Multifoods continued to own Lake & Rail until 1988, when it sold the property to another up-and-coming processor, Omaha-based ConAgra Corporation. ConAgra maintained the merchant mill operations of Lake & Rail, processing bakery trade flours, and continues to operate this lucrative facility today.[12]

MATERIALS HANDLING: HISTORY AND DESCRIPTION

Receiving by Water

As of 1927 grain delivered via lake vessels was unloaded through a pair of mobile marine towers. These steel-framed structures were designed and erected by Monarch Engineering Company of Buffalo as a subcontract. It was unlikely that the prime contractor, Jones-Hettelsater Construction Company of Kansas City, would have accumulated substantial expertise in the field of bulk materials handling at dockside since its previous projects had been located in the Midwest and Southwest. One marine leg was operable by early August when the first cargo of wheat arrived by laker.

The maximum unloading rate of each marine leg was initially specified as 25,000 bu./hr., or a total of 50,000 bu./hr. when both legs were in use simultaneously. Contemporary marine legs at the Marine "A" and Standard elevators were rated at somewhat higher capacities. Each tower presumably contained the customary array of operating equipment common to most structures of this type built in Buffalo during the 1920s--weighing apparatus, an internal lofter leg and electric motors with transitional gear and/or chain drives (rather than rope) for independent functions, including the ship shovels. From the top of the marine lofter, grain was delivered into the elevator via rooftop V-spouting for distribution to storage bins or conditioning units.

During the 1929 navigation season, Lake & Rail handled 15 to 16 million bushels of grain and once elevated 450,000 bushels of barley from the steamer Augustus in 10-1/2 hours. By the early 1950s, an average of sixty lake vessels were calling at the elevator. Unloading each boat required approximately eight hours.[13] Overall marine unloading rates remained constant at the original level of 50,000 bu./hr. through the mid-1960s. Thereafter, the elevator's nominal receiving rate was halved, declining to 25,000 bu./hr. as of 1971 and to 24,000 bu./hr. by 1990.

Receiving by Rail

Grain shipments by rail augmented the lake traffic, particularly during the winter months when elevator stocks had to be replenished to insure continuity of production at International Milling's adjacent flour facility. However, the initial volume of rail receipts was considerably smaller than the quantity of grain handled through the marine towers. A four-track car shed situated west of the workhouse accommodated a pair of car pits. Equipment for unloading boxcars included manually-guided power shovels, and grain was presumably transferred to the boots of the house lofters via belt conveyor.

In 1960 International Milling followed the precedent set at the Standard Elevator (and even earlier at Eastern States in

Tonawanda) by replacing one of Lake & Rail's original car pits with a car dumper.[14] The steel-frame structure housing the dumper was 30' x 84' and 42' deep. Enhancement of car unloading capability was one strategy adopted by Buffalo elevator interests to cope with the diversion of grain traffic to the St. Lawrence Seaway route that opened in 1959. Rather than undertaking the longer journey to the lakehead, some grain traders anticipated an increase in rail shipments for transfer to ocean vessels docking at Buffalo. The two original receiving pits were capable of unloading three cars per hour. The addition of the dumper enabled Lake & Rail to handle five boxcars or four hopper cars per hour, the hopper cars discharging through the track grates without being tilted. This nominal rail receiving rate remained constant through 1990.

Instore Distribution:
Horizontal Transfer and Vertical Handling

Site configuration may exert a decided influence on internal materials handling arrangements, and achieving the objective of optimal storage capacity may result in compromising conventional operating practice. Lake & Rail's unusual footprint, with its annexes angling to the southwest and northwest, dictated rather complex provisions for distribution. Conditions in the original 1927 house and the north and south annexes parallel with the dock are somewhat unusual. The main headhouse features three lofter legs driven at the head pulley by individual electric motors through roller chain power transmission systems. Heat sensors have subsequently been installed on the leg bearings.[15]

In the case of grain received by rail, the cargo was elevated via the lofters and discharged into one of three 2,500-bushel concrete garners over an equal number of 2,500-bushel scales. A complex spouting system occupied the two floors below the scales. Swiveling turnheads on the upper distribution floor directed grain either into universal Mayo-type spouts or to fixed loading spouts leading to the shipping bins. The lower universal distributing spouts discharged either directly into the storage bins within their radius or onto one of the two bin floor conveyors that extended through the north or south annexes. These distribution belts did not run continuously through all sections of Lake & Rail; rather, they were divided at the house lofters in the fashion of the Kellogg and other elevators with centrally located workhouses. The electrical system of the bin floor conveyors was revamped in 1980.[16]

Within the headhouse, provisions were also made for bypassing the scales through tanks at the garner floor which spouted through the upper distribution floor to the bin floor universal spouts. This route may have been intended for grain that had to be turned over or otherwise required conditioning after it had been placed in storage. A series of holding tanks below the bin floor level in the workhouse operated in conjunction with the conditioning units.

Arrangements for moving grain to the Northwest Annex were more complex since its bin floor and that of the mainhouse were on different levels and at right angles to one another. The two bin floor belts running from the workhouse through the North Annex discharged into a boot tank common to a pair of jack legs situated in the north headhouse. These short lofters raised grain up to the level of the two distributing belts in the Northwest Annex. The angle of the Southwest Annex also presumably entailed some deviation from normal linear handling patterns, although in this instance it was not necessary to compensate for any difference in elevation between sections of the elevator. Grain was originally transferred to the flour mill via a conveyor gallery extending west from the junction of the mainhouse and North Annex to the adjacent processing facility. The conveyor gallery remains extant.

Grain Conditioning

Plans originally called for two 6,000 bu./hr. receiving separators to be installed on an extension of the distribution floor north of the headhouse. It appears that these cleaners were not placed in service immediately. Three scalpers were added in the 1930s. A steel grain drier with headhouse was constructed in 1938.[17] Conditioning equipment consisted of a cleaner, drier and scalpers in 1971; the drier was taken out of service later in the decade.

Shipping by Water, Rail or Truck

The process of outstore distribution mirrored the occasionally convoluted movements required on the instore routes. Three shipping conveyors ran through the basement of the 1927 house and the adjoining north and south annexes; as in the case of the bin floor conveyors, these lower belts were divided at the house lofters. The internal legs carried grain up to the headhouse for weighing prior to shipment. The three headhouse scales were partially dedicated to particular shipping patterns. The waterside and central units delivered to fixed rail loading spouts through the swiveling turnheads on the upper distribution floor; the landside scale fed the vessel loading spouts. The 90° angle of intersection between the North and Northwest annexes determined arrangements for retrieving grain from storage in that relatively remote section of the elevator. The two basement conveyors in the Northwest Annex crossed over and discharged onto the shipping belts running to the lofters in the main headhouse.

The nominal marine loading capacity of the original 1927 elevator was approximately 30,000 bu./hr. After construction of the North Annex, filling a Welland canaller with 95,000 bushels took only about two hours. The expanded facility of the 1930s was capable of delivering 20,000 bu./hr. to canal barges and 35,000 bu./hr. to larger vessels through a maximum of seven loading spouts. Between the late 1930s and the mid-1950s marine loading capacity and the number of spouts in service remained constant at an overall level of 40,000 bu/.hr. using six spouts. These figures fluctuated during the late 1950s, perhaps reflecting a modernization program undertaken in conjunction with the opening of the Seaway and the demise of grain traffic through the Erie Barge Canal. In any event, the number of loading spouts was reduced to two while retaining equivalent marine shipping capacity. Vessel loading at Lake & Rail declined through the late 1960s and 1970s; the practice was abandoned completely in 1980.

Published statistics on the elevator's rail loading capability are inconsistent. The four spouts initially in use delivered to cars at a maximum nominal rate of 75,000 bu./hr. At that level of operation, Lake & Rail could load 150 cars over a ten-hour period. By the early 1960s the carloading rate had dropped to 100 cars every ten hours. As of 1971, only two carloading spouts remained in service with deliveries at a rate of 6,000 bu./hr. per spout. This level of performance was maintained up to 1990.

By 1971 provision had also been made for shipments out via truck, though not for vehicle unloading. A single spout loaded grain at the rate of 2,000 bu./hr. In 1980 a second truck spout was in service, increasing overall vehicular shipping capacity to 3,500 bu./hr.

ENDNOTES

1. The following paragraphs are based on information from several sources including plans, contracts and building permits housed in Buffalo City Hall. Accounts of the elevator may be found in Grain Dealers Journal (25 January 1927): 111; American Elevator & Grain Trade (15 February 1927): 499, (15 March 1927): 561, (15 October 1927): 265; and Northwestern Miller (17 August 1927): 635, (7 September 1927): 980. For more information on the South and Southwest annexes see Northwestern Miller (16 January 1929) and (1 January 1930): 73.

2. Herman Steen, Flour Milling in America (Minneapolis: T. S. Denison & Company, Inc., 1963), 275-76; Milton Moskowitz, et al., eds., Everybody's Business (New York: Harper & Row, 1980), 82.

3. Moody's Industrials, 1931.

4. Erie County Clerk (ECC), Corporations, Lake & Rail Warehouse & Elevator Corporation, Certificate of Incorporation, November 8, 1926, Consent to Mortgage, December 2, 1926, Box 15885; Moody's Industrials, 1931. All Erie County Clerk documents are listed by date of document origin, not by date of filing, unless otherwise noted.

5. ECC, Deeds, Liber 1794, January 11, 1925, 419-21.

6. Buffalo Live Wire, XVII/12 (December 1926), 14; XVIII/1 (January 1927), 6-7; Buffalo City Hall, Permits and Plans, Permit #5862, February 24, 1927; Permit #11588, April 28, 1928; Permit #15365, April 10, 1929; Permit #15503, April 17, 1929; Permit #20286, October 3, 1930; Northwestern Miller (4 May 1927) and (17 August 1927); Buffalo and Erie County Public Library, Scrapbooks, "Industry," Vol. 7, p. 180.

7. Steen, Flour Milling in America, 277, 278; Buffalo Live Wire XVIII/9 (September 1927), 3, 22.

8. Moody's Industrials, 1931; ECC, Corporations, Lake & Rail, Warehouse and Elevator Corporation, Certificates of Election, 1928, 1931, 1934, 1936, Box 15855.

9. ECC, Corporations, Lake & Rail, Warehouse & Elevator Corporation, Certificate of Dissolution, September 3, 1937, Consent to Mortgage, August 27, 1935, Box 15855; Deeds, Liber 2698, September 4, 1937, 451-56.

10. Buffalo Evening News, 15 August 1963, p. 47.

11. Jim Hightower, Eat Your Heart Out (New York: Crown Publishers, Inc., 1975), 105, 132.

12. ECC, Deeds, Liber 9853, p. 399.

13. Buffalo & Erie County Public Library, Local History Scrapbooks, "Industry," Vol. 7, p. 180 (Buffalo Evening News, 3 December 1951).

14. Building Permit #81905 (12 April 1960)

15. Building Permit #E12543 (31 December 1979)

16. Building Permit #E12970 (19 March 1980)

17. Building Permit #30538 (5 October 1938)

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Unless indicated otherwise by footnotes, all information about machinery and process flows has been derived from the following sources.

American Elevator & Grain Trade (15 February 1927): 499; (15 March 1927): 561; (15 October 1927): 265.

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40th ed. (1948), 339.
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48th ed. (1956), 348.
53rd ed. (1961), 326-327.
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War Department, Corps of Engineers, United States Army, [Transportation Series #1] Transportation on the Great Lakes (Washington: Government Printing Office, 1937) 245.

APPENDIX

Mainhouse

Cost:	$300,000
Foundation:	Concrete sub-piers of 5' diameter with vertical and horizontal reinforcing support 12" thick floor slab reinforced by upper and lower rods in grid that links sub-piers
Basement:	Six longitudinal rows of rectangular, bracketed pillars support transverse beams, which in turn support a 12" bin slab Transversely the pillars are not equally spaced and dimensions vary; four pillars and two basement beams below each main bin; pillars on the outer row lie below the intersection of main and 1/4 exterior walls; depth of basement beams varies from 3'-6" in outer aisles to 2'-6" in inner aisles; beams reinforced with trussed 1-1/4" and 1-1/2" round rods; bin slab reinforced with a regularly spaced grid of round rods; 10' height to bin slab; 1/3 above grade; lit by small top lights
Hoppers:	Mortar slab on slag concrete above bin slab Central draw-off via conical hoppers spouts set into bin floor
Bins:	Capacity 1,600,000 bushels Main bins 10 x 3 in parallel rows, cylindrical 23'-2" in diameter, 110' high above bin slab 16 interspace bins 20 outerspace bins; convex circle outer walls absent on Southeast end elevation; one outerspace below workhouse used for elevator and stairs Square bins, 10 overhead bins in workhouses below cleaners, 6' x 6' Bin contacts, transversely tangential, longitudinally non-tangential, contact by straight link walls; tangential intersections 8' wide, link walls 4'-4" long and 8" wide Bin wall thickness 8" Vertical reinforcing, including jacking rods, 1/2" round rod in 13' lengths on 2'-6"

	centers 9 jacking rods per outer main bin, 8 per interior bin, 2 per quarter wall; verticals centered 3" from outer wall surface
	Horizontal reinforcing wired to outside of verticals; graduated round rod at varying course intervals in both main and 1/4 walls Link walls and contact anchors of 1/2" rod bent about verticals; link contacts doubled
Bin Floor:	Concrete on longitudinal I-beams, conveyors set in 7' wide, 3'-6" deep trough within floor
Gallery:	Monolithic concrete
Workhouse:	Monolithic concrete with concrete garner bins

REFERENCES: Original plans and contract are housed in Buffalo City Hall. The City Plans Book for 1927 provides the costs and building permits the dates. Supplementary information may be found in <u>Grain Dealers Journal</u> (25 January 1927): 111 and <u>American Elevator & Grain Trade</u> (15 February 1927): 499; (15 March 1927): 561; (15 October 1927): 265 and <u>Northwestern Miller</u> (17 August 1927): 635; (7 September 1927): 980.

<u>North Annex</u>

Cost:	$100,000
Foundation:	Concrete sub-piers of 5' diameter with vertical and horizontal reinforcing supports 12" thick floor slab reinforced by upper and lower rods in a grid that links sub-piers
Basement:	Six longitudinal rows of rectangular, bracketed pillars support transverse beams, which in turn support a 12" bin slab Transversely the pillars are not equally spaced and dimensions vary; four pillars and two basement beams below each main bin; pillars on the outer row lie below the intersection of the main and 1/4 exterior walls; depth of the basement beams varies from 3'-6" in outer aisles to 2'-6" in inner aisles; beams reinforced with trussed 1-1/4" and 1-1/2" round rods; bin slab reinforced with regularly spaced grid of round rods; 10'

	height to bin slab; 1/3 above grade; lit by small top lights
Hoppers:	Mortar slab on slag concrete above bin slab Central draw-off via conical hoppers spouts set into bin floor
Bins:	Capacity 650,000 bushels Main bins 4 x 3 in parallel rows, cylindrical 23'-2" in diameter, 110' high above bin slab; 2 within north elevation subdivided for shipping Interspace bins 4 x 2 8 outerspace bins Bin contacts, transversely tangential Longitudinally non-tangential by straight link walls; tangential intersections 8' wide, link walls 4'-4" x 8" Wall thickness 8", at tangential contacts 8" Vertical reinforcing, including jacking rods, 1/2" round rod in 13' lengths on 2'-6" centers Jacking rods, 9 per outerspace main bin, 8 per interior bin, 2 per quarter wall Verticals centered 3" from outer surface of bin wall Horizontal reinforcing wired to outside of verticals; graduated round rod at varying course intervals in both main and 1/4 walls Link walls and contact anchors of 1/2" rod bent about verticals; link contacts doubled
Bin Floor:	Monolithic concrete on longitudinal I-beams Conveyors set in 3'-6" deep trough within floor
Gallery:	Monolithic concrete

REFERENCES: Original plans are housed in Buffalo City Hall. The City Plans Book for 1928 provides the costs and building permits the dates. Supplementary information may be found in <u>Northwestern Miller</u> (28 March 1928) and (1 January 1930).

<u>South & Southwest Annexes</u>

Cost:	$250,000
Foundation:	Concrete sub-piers of 5' diameter with vertical and horizontal reinforcing supports

12" thick floor slab reinforced by upper and lower rods arranged in grid linking sub-piers

Basement: Six longitudinal rows of rectangular, bracketed pillars support transverse beams, which in turn support a 12" bin slab Transversely the pillars are not equally spaced, and their dimensions vary; four pillars and two basement beams below each main bin; pillars on the outer row lie below the intersection of the main and 1/4 exterior walls; depth of the basement beams varies from 3'-6" in outer aisles to 2'-6" in inner aisles Beams reinforced with trussed 1-1/4" & 1-1/2" round rods; bin slab reinforced with regularly spaced grid of round rods; arrangements become more complex in southwest house due to diagonal south wall and curved taper of north wall; basement height 10' to bin slab 1/3 above grade; lit by small toplights

Hoppers: Mortar slab on slag concrete above bin slab Central draw-off via conical hoppers spouts into bin floor

Bins: Capacity 1,000,000 bushels
South Annex: main bins, 3 parallel rows of cylindrical bins, 5 x 23-2", 4 x 23'-2", 1 x 14'-4", 4 x 32'-2", 110' high above bin slab
Southwest Annex: 16 cylindrical bins varying in diameter from 32'-2" to 14'-4" to accommodate site geometry
South & Southwest annexes: 21 interspace bins of various geometries
21 outer bins between all exterior main bins
Tangential contacts between most bins; block of regularly spaced 3 x 3 main bins in South Annex has transversely tangential bin contacts; longitudinal contacts are by straight link walls; tangential contacts 8' wide, link walls 4'-4" x 8"
wall thickness 8" at tangential contacts 8"
Vertical reinforcing, including jacking rods, 1/2" round rod in 13' lengths on 2'-6" centers Jacking rods, 9 per outer main bin, 8 per interior bin, 2 per quarter wall; verticals centered 3" from outer surface of bin wall

	Horizontal reinforcing wired to outside of verticals; graduated round rod at varying course intervals in both main and 1/4 walls Link walls and contact anchors of 1/2" rod bent about verticals; link contacts doubled
Bin Floor:	Monolithic concrete on longitudinal I-beams, conveyors set in 3'-6" deep trough within floor
Gallery:	Monolithic concrete
Workhouse:	Monolithic concrete with concrete garner bins

REFERENCES: Original plans are housed in Buffalo City Hall. The City Plans Book for 1929 provides the costs and building permits the dates. Supplementary information may be found in Northwestern Miller (16 January 1929) and (1 January 1930): 73.

Northwest Annex

Cost:	$220,000
Foundation:	Concrete sub-piers of 4'-6" diameter with vertical and horizontal reinforcing supports 12" thick floor slab
Basement:	Rectangular non-bracketed pillars support a 15" bin slab; columns located beneath the bin link walls and extend upward into the bin floor for the first 20' above the bin slab; basement 9'-9" high, at grade
Hoppers:	Mortar slab on slag concrete above bin slab Central draw-off via conical hoppers spouts set into bin slab
Bins:	Capacity 1,150,000 bushels Main bins 14 x 3 in parallel rows, cylindrical 15' in diameter, 150' high above bin slab, one bin sub-divided horizontally Interspace bins 13 x 2 30 outerspace bins with straight exterior walls; 11 square overhead bins between elevator and mill Non-tangential bin contacts; link walls 2' long transversely, and 1' longitudinally

Bin wall thickness 6"
Vertical reinforcing, including jacking rods, all 1/2" round rod, on 2'-6" centers; ordinary verticals 15' long, jacking rods 3' long, 6" segments
Horizontal reinforcing uniformly round rod at varying course intervals; three 18' rods per bin overlapped by 18"; horizontals wired to outside of verticals

Bin Floor: Monolithic concrete on longitudinal I-beams.

Gallery: Monolithic concrete

REFERENCES: Original plans are housed in Buffalo City Hall. The City Plans Book for 1930 provides the costs and building permits the dates.